# Modeled De Facto Reuse in Drinking Water Sources in the Colorado River Basin

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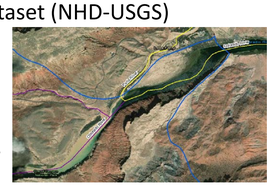
## Introduction

- De facto potable reuse (DFR) occurs when treated wastewater is discharged into the upstream of drinking water treatment plants (DWTPs)
- While wastewater treatment plants (WWTPs) may comply with National Pollutant Discharge Elimination System (NPDES) discharge permits, studies have detected the occurrence of contaminants of emerging concern (CECs) at drinking water sources downstream
- A recent study on the occurrence of DFR has been assessed at national scale, but it is limited to the DWTPs serving greater than 10,000 people
- This study will look at all-sized DWTPs in the Colorado River Basin for potential impacts of upstream treated wastewater discharging to surface waters

## Modeling Approach

- An ArcGIS-based model of "De Facto Reuse Incidence in our Nations Consumable Supply (DRINCS)" (Rice and Westerhoff, 2014)
- In Colorado River Basin: 7 counties, 416 surface water intakes by 243 DWTPs and 155 wastewater outfalls to surface water by WWTPs
- Stream flow database (1:100,000 scale) from US Geological Survey-National Hydrography Dataset (NHD-USGS)
- Region 14
- Ground-truthing surface water intakes
- Python program to calculate accumulated treated wastewater



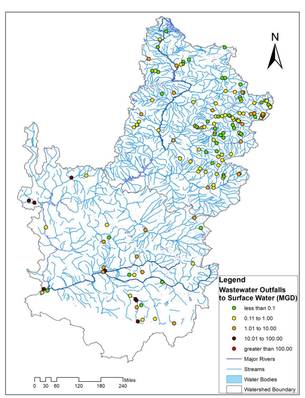



Fig 1. Spatial distribution of treated wastewater discharge into surface water in Colorado River Basin

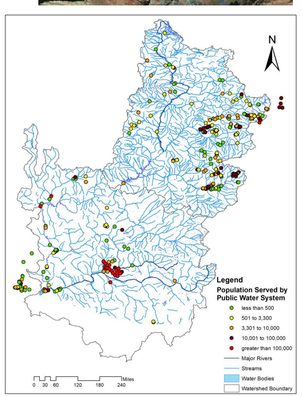
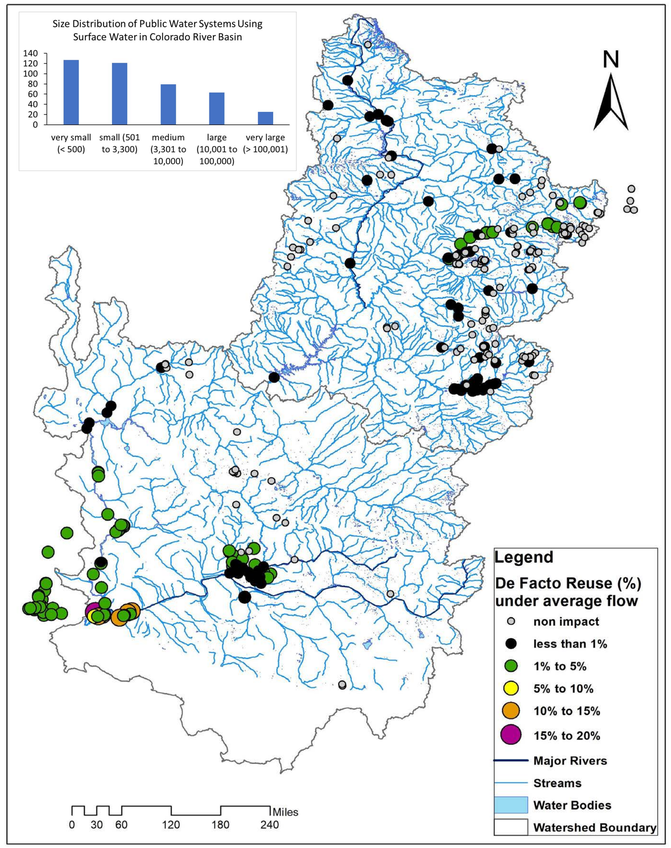
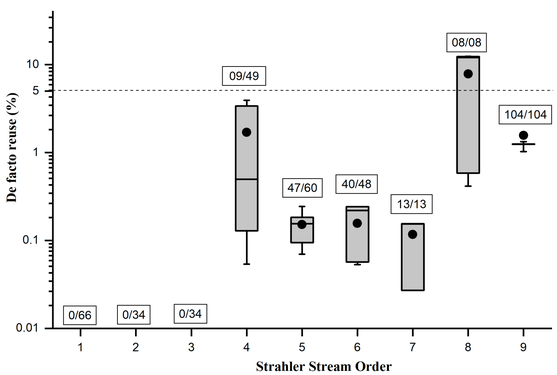



Fig 2. Population served by DWTPs using surface water in Colorado River Basin

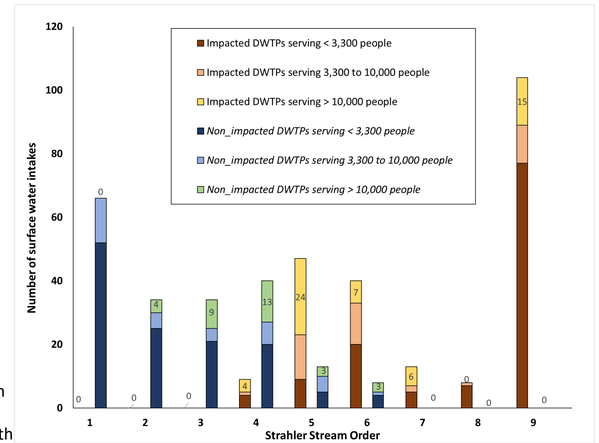
## Modeled Results

- **Spatial occurrence of DFR under average flow conditions**
  - About 47% of DWTP intakes not impacted by upstream wastewater discharge
  - Impacted DWTP intakes are located in lakes and reservoirs (n = 104), streams and creeks (n = 90) and canals/ditches/gulch (n = 27)
  - About half of DWTP intakes with less than 5% for estimated DFR
  - DWTP intakes located in the southwestern of Lower Colorado River Basin have up to 20% DFR under average flows
  - Canal systems transporting surface water from Colorado River Basin (the Colorado-Big Thompson project to Colorado or All-American Canal to northern part of California systems)
- **Magnitude of DFR under average flow conditions**
  - Most of drinking water sources at stream orders from four-order to nine-order were impacted by wastewater upstream
  - The highest estimated magnitude of DFR at Strahler stream order 8 (Gila river)
  - The highest number of impacted intakes by treated wastewater upstream at Strahler stream order 9 (Colorado river)



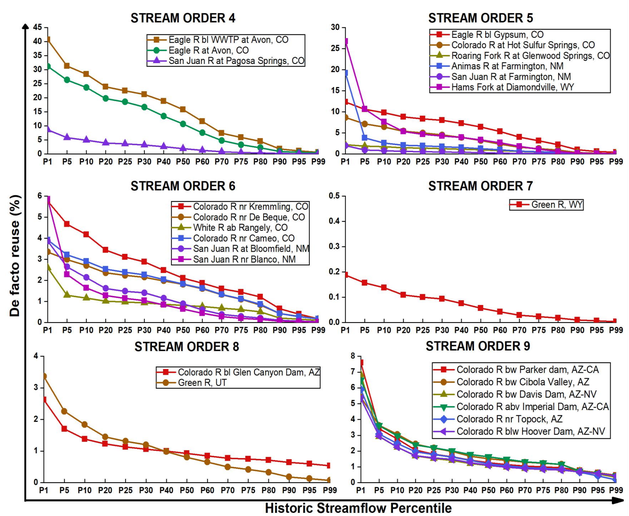



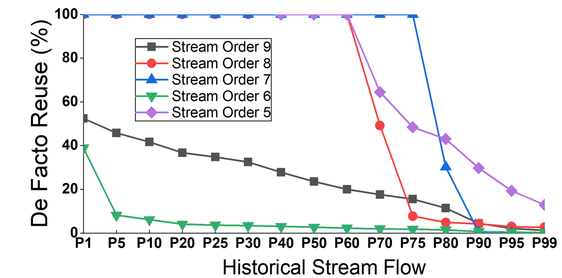

Top and bottom of box = 75th and 25th percentiles respectively; top and bottom of whisker = 90th and 10th percentiles respectively; line across inside of box = median (50th percentile). 00/66 = 00 is the number of surface water intakes with DFR>0 upstream WWTPs and 66 is the total DWTP intakes)




## Modeled Results (cont.)

- **Magnitude of DFR under varied stream flow conditions**




## Conclusions

- High occurrence of DFR (associated CECs) at downstream drinking water intakes during droughts, which is the design condition for WWTP effluents
- More of small DWTPs are likely impacted by CECs in the Colorado River Basin
- Analysis using DRINCS could help investigate DWTPs at higher risk of de facto potable reuse of municipal wastewater and supports monitoring efforts by identifying highly impacted areas.

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